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AIR POLLUTION IN ST. BERNARD, OHIO

E. C. Tabor, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1958

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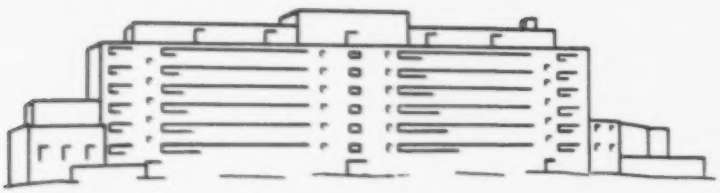

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U.S. DEPARTMENT OF HEALTH,
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Public Health Service

1958

AIR POLLUTION IN ST. BERNARD, OHIO

A report on a study conducted
January 16 - March 15, 1956,
at the request of the St.
Bernard Board of Health.

E. C. Tabor, Chief, and J. E.
Meeker, Chemist, National Air
Sampling Network; J. M. Leavitt,
USWB, Meteorology Unit.

Community Air Pollution Program

Details of illustrations in
this document may be better
studied on microfiche.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of State Services
Division of Sanitary Engineering Services

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AIR POLLUTION IN ST. BERNARD

INTRODUCTION

A two-month (Jan. 16 - March 15, 1956) study to determine the level of air pollution experienced by a residential area in St. Bernard, Ohio, was undertaken in response to a request from the Board of Health of that community.

The St. Bernard situation is representative of a class of air pollution problems wherein the source and receptor may be in separate jurisdictions. The receptor jurisdiction is thereby prevented from making intensive source emission studies, as would normally be done were both sources and receptor in the same control jurisdiction. In this particular situation, jurisdictional relationships are still further complicated by the fact that St. Bernard is completely surrounded by the city of Cincinnati, Ohio, and is therefore, subject to the generalized air pollution of the greater Cincinnati area, a metropolitan complex of over more than a million population.

THE SAMPLING STATION

Since the study was made at the request of the St. Bernard Board of Health, the sampling site had to be in St. Bernard and as near as possible to the receptor residential area concerned. An unused one-story public playground building meeting these specifications was therefore selected as the sampling site (Fig. 1). The instrumentation installed in this building included (Fig. 2, from left to right) a pair of Esterline-Angus recorders which made continuous records of wind direction and speed, a Beckman-Whitley translator, a connector unit between the recorders and the wind vane and anemometer mounted atop a 40 foot pole about 100 yards west of the building; an Aseco auto-impinger, used at different times during the study for the measurement on an hourly cycle of oxides of nitrogen or sulfur dioxide; a National Air Sampling Network type high-volume glass fiber filter sampler operated on a 24-hour cycle; an AISI hydrogen sulfide sampler operated on a 6-hour cycle, and an AISI tape sampler operated on a 3-hour cycle. The sampling tube is to the right of the photograph goes to a Thomas Autometer, not shown in the picture, which recorded the sulfur dioxide level continuously on a strip chart.

Once installed all sampling and meteorological instruments were kept in operation 24 hours per day, seven days per week for the duration of the study, except for outage due to instrument failure. Because installation of sampling equipment was spread over several weeks and because outage differed between instruments, the length of record is longer from some instruments than others. The recorded periods are as follows:

Equipment	Days
Esterline-Angus recorders (wind direction and speed)	48
AISI hydrogen sulfide sampler	48
AISI tape sampler (soiling power)	40
Thomas Autometer (sulfur dioxide)	28
Aseco auto-impinger (sulfur dioxide)	15
Aseco auto-impinger (oxides of nitrogen)	4
High volume filter sampler	23

EQUIPMENT PERFORMANCE

Data from three of the above seven sets of records were found to have no value in answering the questions posed by the study.

The hydrogen sulfide sampler gave no usable data because, despite the fact that the tape was proven sensitive to hydrogen sulfide, no discoloration due to the presence of this gas was detected during 1152 hours of operation.

Automatic impinger data for oxides of nitrogen also were unusable, because it was demonstrated during the study period that at the flow rates employed, with the background of sulfur dioxide present, and the Saltzman reagent technique used, the automatic impinger was not satisfactory for this measurement. The sampling efficiency was not high enough for the results to be reliable. In fact, on several occasions, oxides of nitrogen that could be detected by odor and visibly traced as a plume from the source were not detected in the impinger sample.

Figure 1. ST. BERNARD AREA

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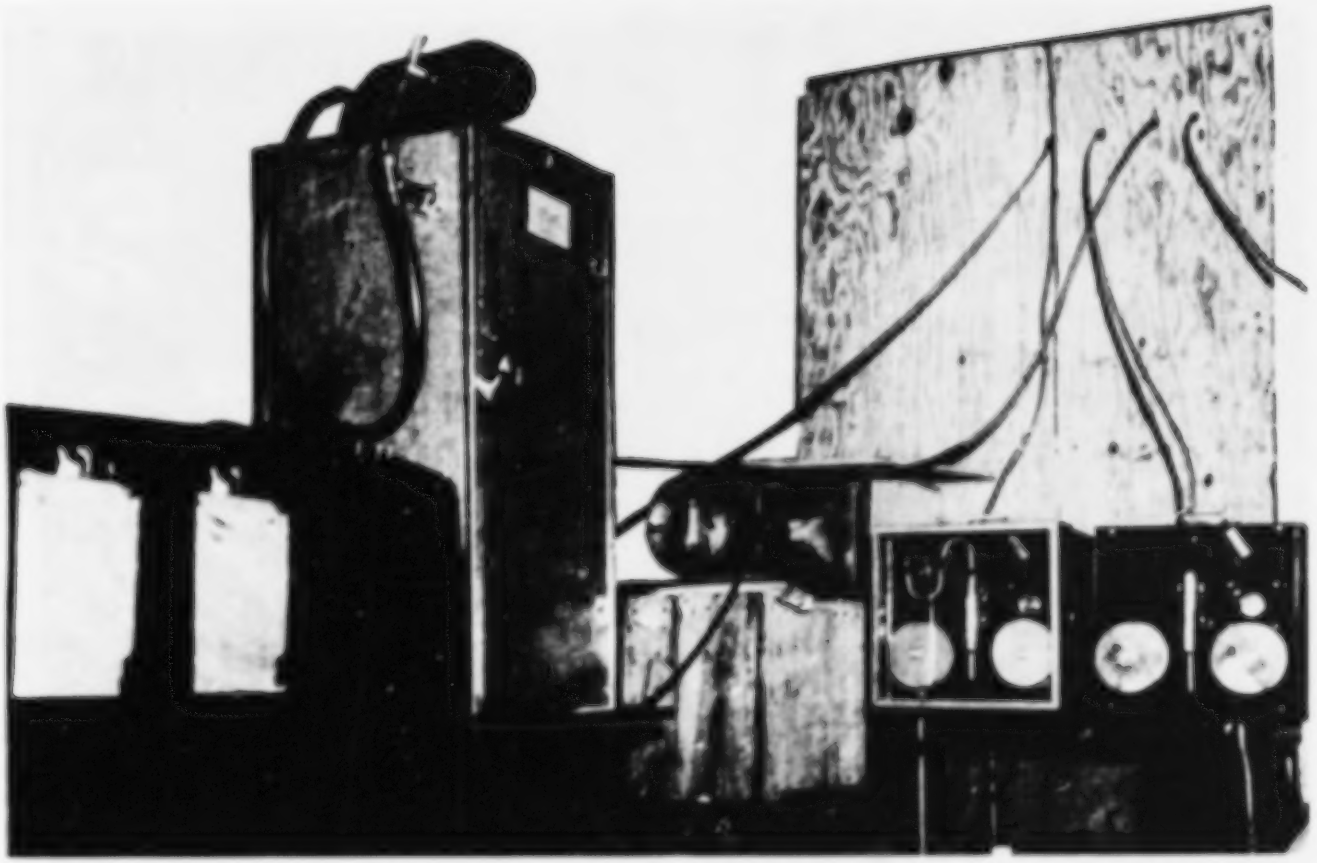

Figure 2. ARRAY OF INSTRUMENTS IN SAMPLING STATION. Left to right: wind speed and direction recorders; translator unit for wind instruments, Auto impinger; high volume filter sampler; AISI hydrogen sulfide sampler; AISI tape sampler for measurement of soiling power.

Automatic impinger operation for sulfur dioxide was generally satisfactory. However, because the Autometer yielded the same information as the impinger but with greater detail, Autometer data were used.

CORRELATION OF SULFUR DIOXIDE AND SOILING POWER WITH WIND DIRECTION

Of the remaining continuous samplers -- data from the Autometer and AISI sampler (3-hour cycles) could be correlated with continuous wind data. The High-Volume Sampler, since it was on a 24-hour cycle, did not lend itself to correlation with the variabilities of wind direction and speed during the 24-hour sampling periods.

Average sulfur dioxide and soiling power values in St. Bernard were comparable with those found elsewhere in greater Cincinnati during the study period, except for the considerably higher soiling power values at the downtown Cincinnati station. The analysis of sulfur dioxide and soiling power data with respect to wind direction (Table 1 and 2) indicate higher values during periods with northerly winds. More specifically, during periods when the winds were from the N to NNE sectors, sulfur dioxide concentrations were three to four times the average for periods with winds from the outer sectors. Winds from the WNW through E sectors had a mean soiling power of 9.8, compared to 6.4 for the remaining sectors. Since several industrial plants lie N and NE of the sampling site, these findings are significant. Daily sulfur dioxide and soiling power levels are shown in Tables 3 and 4.

HIGH-VOLUME FILTER SAMPLES

High-volume filter samples were taken at the rate of approximately 50 cfm through 8 x 10-inch tared glass fiber filters for 24 hours, after which the filters were again weighed. Portions of the filters were used for analysis of the collected particulate matter for sulfates, nitrates, and chlorides, using National Air Sampling Network techniques (Table 5). Although the suspended particulate determined in this manner was only moderately higher in St. Bernard than in a comparative site in greater

Cincinnati (Table 6), there was a marked excess of sulfates and nitrates in the St. Bernard samples compared to those from downtown Cincinnati. This excess is most likely attributable to adjacent industrial sources.

A portion of each filter was extracted with benzene for eight hours. A much larger amount of benzene extractable material was found in these samples than in those from the Cincinnati site (Table 6). Not only was the benzene extractable content of St. Bernard air high in comparison with both downtown Cincinnati and other cities in the United States, but the percent of neutral aliphatic hydrocarbons in a composite St. Bernard sample (Table 7) also was high. The amount of neutral aliphatic hydrocarbons normally found ranges from 15 to 30 percent of the benzene-soluble material. Thus, the neutral aliphatic hydrocarbon content of St. Bernard air was, during the test period, from two to five times higher than that normally found elsewhere.

Conclusions based on high-volume sample analysis cannot be considered firm, because a relatively high percentage of the total wind during the study period (Table 8) was from the west and south quadrants. There was, however, a large enough component from the north and east quadrants to have transported pollution from the north and northeast into the receptor area.

CONCLUSIONS

1. The levels of suspended particulates and crude organics found in St. Bernard were considerably higher than that in downtown Cincinnati for the same days.

2. The average levels of 270 micrograms of suspended particulate per cubic meter of air and 65.5 micrograms of crude organics per cubic meter of air were somewhat higher than for other communities of size comparable to St. Bernard. Nitrate and sulfate concentrations also were slightly higher.

3. The highest levels of sulfur dioxide, while not high enough to be of great concern, were associated with northerly winds.

4. On several occasions the level of oxides of nitrogen was high enough to be detectable by the odor.

5. The large amount of aliphatic hydrocarbons in the organic matter was very unusual. It was considerably higher than that from any other community in the United States for which similar measurements have been reported.

6. The soiling power of the air was higher when the wind blew from the North.

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Table 1. RELATION OF SULFUR DIOXIDE LEVELS TO WIND DIRECTION

Wind	Sulfur Dioxide SO_2, ppm	Wind	Sulfur Dioxide* SO_2, ppm
N	.079	S	.017
NNE	.048	SSW	.015
NE	.020	SW	.014
ENE	.025	WSW	.030
E	.021	W	.018
ESE	.022	WNW	.038
SE	.008	NW	.023
SSE	.003	NNW	.030

* Average concentration measured continuously with a Thomas Autometer.

Table 2. RELATION OF SOILING POWER TO WIND DIRECTION

Wind	Soiling Power, RUDS	Wind	Soiling Power,* RUDS
N	8.3	S	7.7
NNE	10.7	SSW	6.1
NE	9.0	SW	6.8
ENE	9.4	WSW	6.3
E	12.6	W	7.7
ESE	9.4	WNW	8.3
SE	6.0	NW	7.3
SSE	3.5	NNW	9.2

* Sampling on a 3-hour cycle.

Table 3. SULFUR DIOXIDE (AUTOMETER)

Date 1956	Average PPM for 3-hour period ending -							
	3AM	6AM	9AM	12N	3PM	6PM	9PM	12M
Jan:								
25	.01	.00	.00	.00	.01	.03	.06	.01
26	.02	.06	.18	.14	.02	.00	.04	.06
27	.02	.04	.03	.02	.00	.00	.00	.00
30	.00	.00	.02	.05	.03	.00	.00	.02
31	.04	.05	.06	.11	.18	.06	.02	.01
Feb:								
1	.01	.00	.01	.04	.03	.03	.02	.00
2	.00	.00	.02	.02	.01	.00	.04	.11
3	.15	.10	.00	.00	.00	.00	.01	.02
4	.07	.06	.01	.05	.04	.01	.02	.02
5	.01	.13	.04	.03	.01	.00	.00	.00
6	.06	.04	.10	.01	.00	.00	.01	.01
7	.00	.00	.00	.00	.00	.00	.06	.22
8	.00	.00	.00	.03	.00	.03	.03	.05
10	.02	.05	.01	.00	.09	.03	.00	.00
15	.06	.09	.08	.07	.04	.06	.01	.02
22	.02	.01	.01	.00	.00	.02	.02	.06
23	.06	.21	.04	.02	.03	.03	.03	.02
27	.00	.00	.00	.02	.00	.00	.06	.05
28	.01	.01	.05	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.01	.02	.02	.07
Mar:								
1	.07	.05	.01	.01	.00	.00	.00	.00
6	.00	.00	.03	.02	.05	.02	.09	.04
7	.02	.04	.03	.00	.00	.00	.00	.00
8	.03	.04	.02	.00	.00	.03	.05	.04
10	.04	.04	.04	.00	.00	.00	.00	.00
11	.00	.00	.01	.03	.09	.13	.09	.02
12	.06	.03	.03	.10	.33	.09	.00	.00
13	.01	.01	.03	.00	.00	.05	.03	.02
14	.01	.01	.01	.04	.06			

Table 4. SOILING CAPACITY

Date 1956	Total RUDS* per 5000 linear feet for 3-hour period ending -							
	3AM	6AM	9AM	12N	3PM	6PM	9PM	12M
Jan:								
24	14	13	14	11	5	6	8	11
25	8	8	11	9	10	11	12	13
26	16	26	-	-	11	9	20	-
27	21	19	20	18	9	8	10	-
28	11	11	10	8	8	10	11	9
29	7	8	11	7	6	8	8	9
30	6	5	10	6	6	3	8	7
31	8	9	15	15	21	12	17	23
Feb:								
1	14	8	11	10	10	8	6	8
2	7	7	18	16	10	11	14	14
3	10	8	6	8	4	7	10	14
4	12	11	12	12	12	11	13	12
5	14	12	16	9	6	5	7	10
12	5	5	5	7	4	5	7	5
13	5	7	6	6	5	4	8	8
14	6	7	15	12	7	9	12	11
15	8	7	7	12	6	5	-	6
16	5	5	8	8	7	8	10	10
17	8	14	15	7	6	11	16	14
18	14	6	6	6	5	4	10	25
19	22	15	11	10	9	8	9	6
20	8	8	11	5	5	5	8	12
21	8	6	8	8	9	6	6	5
22	6	6	11	5	4	5	6	8
23	6	6	8	5	4	4	7	8
24	5	6	7	7	6	5	4	4
29	7	9	18	8	4	4	9	28
Mar:								
1	26	17	10	6	4	6	5	4
2	4	5	6	4	2	4	11	29
3	24	20	23	14	5	5	6	13
4	8	11	15	6	5	4	7	11
5	10	10	15	6	4	3	4	-
7	3	3	5	5	3	4	4	3
8	1	1	4	4	4	4	4	6
9	8	9	16	10	4	4	9	10

Table 4. SOILING CAPACITY (Continued)

10	20	22	23	10	4	4	5	4
11	5	4	4	4	2	2	5	4
12	5	4	5	7	7	5	6	9
13	18	13	15	6	5	5	6	8
14	5	4	6	6	6	6	8	10

* RUDS, reflectance units of dirt shade.

Table 5. AIR PARTICULATE RESULTS

Date 1956	Org.extr. ug/cu.M.	Particulates ug/cu.M.	Chloride ug/cu.M.	Nitrate ug/cu.M.	Sulfate ug/cu.M.
Jan:					
23	25	291	0.8	4.1	34.6
24	28	238	0.3	5.3	34.0
25	40	421	1.0	10.8	42.5
26	71	369	1.3	6.0	38.4
30	81	326	0.5	4.6	34.1
31	44	322	0.1	6.3	28.1
Feb:					
8	82	291	0.3	2.3	14.7
13	76	177	0.1	1.1	9.7
14	55	186	0.1	2.1	17.1
15	29	228	0.1	4.5	25.2
20	70	258	0.1	3.2	12.4
23	57	159	0.1	2.4	9.9
28	40	275	1.5	2.7	17.9
29	159	363	0.5	2.1	17.6
Mar:					
1	99	216	0.2	1.3	9.0
5	85	182	0.2	0.5	8.0
6	97	179	0.1	1.5	11.6
7	86	142	0.3	0.9	10.3
8	123	219	0.1	1.2	15.1
12	49	416	1.4	8.9	39.6
13	25	312	1.7	9.2	37.5
14	43	335	0.9	10.8	45.4
15	29	319	1.3	12.3	38.4

Table 6. COMPARISON OF ST. BERNARD AND CINCINNATI AIR PARTICULATE LEVELS

Date 1956	City	Concentrations, micrograms per cubic meter of air				
		Suspended particulates	Benzene-soluble	Sulfates	Nitrates	Chlorides
Jan:						
25	St.Bernard	421	41	42.5	10.8	1.0
	Cincinnati*	198	17	28.7	1.1	0.3
Feb:						
8	St.Bernard	291	-	14.7	2.3	0.3
	Cincinnati	229	-	10.9	0.5	0.5
15	St.Bernard	228	29	25.2	4.5	0.1
	Cincinnati	145	9	12.8	0.4	0.4
Mar:						
1	St.Bernard	216	99	9.0	1.3	0.2
	Cincinnati	104	9	7.3	0.5	0.8
7	St.Bernard	142	86	10.3	0.9	0.3
	Cincinnati	88	13	13.1	0.4	0.7
14	St.Bernard	335	43	45.4	10.8	0.9
	Cincinnati	159	13	25.6	1.1	0.4
Aver-age	St.Bernard	272	59	24.5	5.1	0.5
	Cincinnati	154	12	16.4	0.7	0.5

*Cincinnati observations were at Lincoln Park Drive Station.

Table 7. COMPOSITION OF BENZENE-SOLUBLE PARTICULATE MATTER FROM ST. BERNARD, CINCINNATI, AND LOS ANGELES

Component	Percent of total for each city		
	St. Bernard	Cincinnati	Los Angeles
Aliphatic hydrocarbons	65.6	33.0	19.0
Aromatic hydrocarbons	14.1	19.0	14.3
Neutral oxygenated hydrocarbons	6.8	24.0	18.2
Acids: phenols, acids, etc.	3.8	lost	18.0
Insoluble in ether and water	2.0	9.7	13.3
Bases: amines, etc.	1.2	0.9	0.2
Water soluble	1.0	0.6	5.5
Losses on analysis	5.5	-	11.5
	100.0		100.0

Table 8. PERCENT OF TIME WIND BLEW FROM EACH DIRECTION DURING THE STUDY

Wind direction*	Percent	Wind direction*	Percent
N	3.6	S	2.4
NNE	6.0	SSW	10.4
NE	12.4	SW	8.0
ENE	4.4	WSW	12.9
E	10.4	W	6.8
ESE	5.2	WNW	3.2
SE	1.2	NW	6.4
SSE	0.8	NNW	5.6

*Indicated direction represents a 22.5° sector; e.g., N=349°-011°. Calms omitted as of very limited occurance.